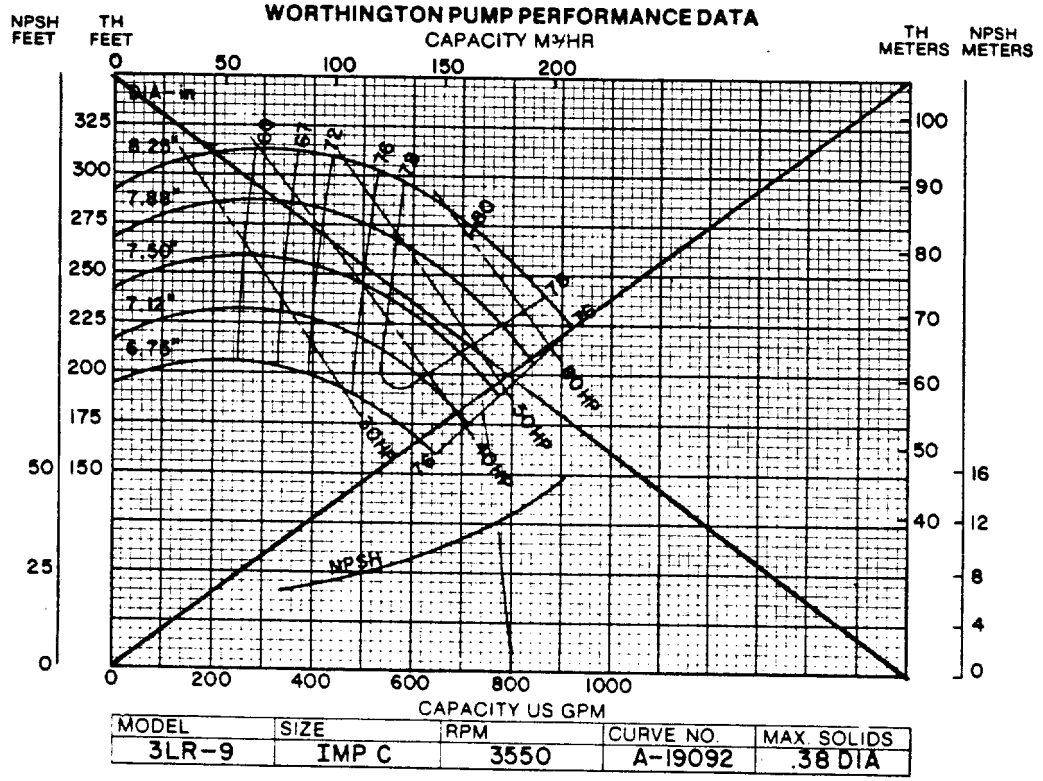
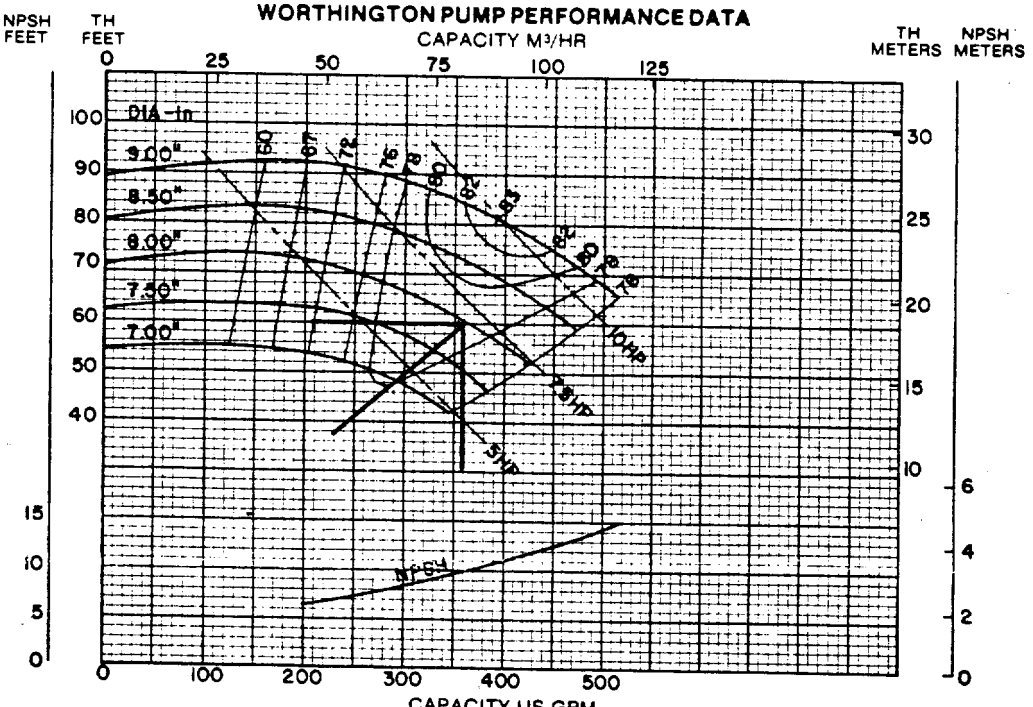
Customer Mechanical Constructors Inc. Work Order No. 447-56088
Project _____ Proposal/Order No. 60-750634
Cust. Proposal/Order No. 28755 Certified By Samuel P. Briley
Customer Item No. 3, CONDENSATE P-1 & P-2 Date 8/26/85
Liquid/Service WATER Sp. Gr. .943 Visc. _____ SSU
Capacity 360 Head 60 Temp. 250 °F/X Consistency 78 %



MODEL	SIZE	RPM	CURVE NO.	MAX. SOLIDS
3LR-9	IMP C	3550	A-19092	.38 DIA

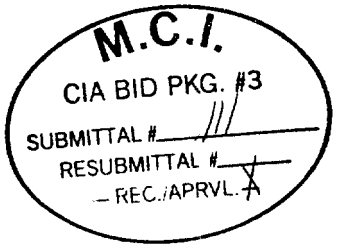


MODEL	SIZE	RPM	CURVE NO.	MAX. SOLIDS
3LR-9	IMP C	1760	A-19093	.38 DIA

Centrifugal Pumps

Instruction Manual and Parts List

Types LR, LLR and Fire Pumps LRG



McGRAW-EDISON

Worthington

Approved For Release 2005/11/17 : CIA-RDP02-06298R000900050016-3

FOREWORD

The Worthington pump in your possession is the result of over a century of progressive hydraulic engineering, and is scientifically designed and built to give long and dependable service. To accomplish this, Worthington maintains a staff of skilled designers, consultants and field engineers to assist you in your pumping problems. In addition, careful manufacturing and selection of materials assures you of a pump of superior performance.

If given proper care and handling your pumping units should give years of trouble-free performance. This booklet is furnished to point out the essentials of proper handling and to acquaint you with your unit. Read this booklet, comply with its instructions and your pump will serve you well.

WARNING

Do not operate this equipment in excess of its rated capacity, speed, pressure and temperature, nor otherwise than in accordance with the instructions contained in this Manual. This equipment (or a prototype) has been shop-tested and found satisfactory for the conditions for which it was sold, but its operation in excess of these conditions will subject it to stresses and strains which it was not designed to withstand.

Failure to heed this warning may result in an accident causing personal injury.

INTRODUCTION

This booklet gives instructions which apply to Worthington's LR, LLR and LRG Horizontal Split-Case Centrifugal Pumps. Essentially, there are three basic types of horizontal split-case pumps in this line, namely:

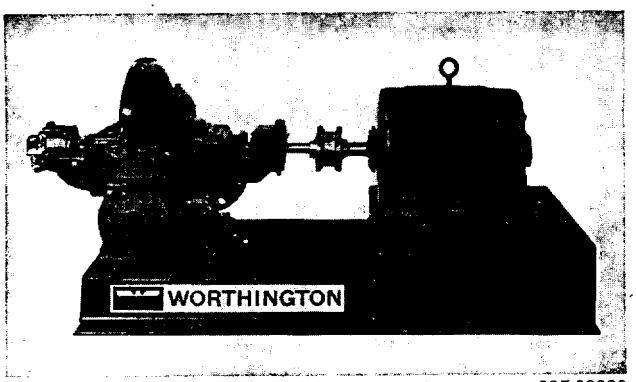
Type LLR Single-Suction Two-Stage Pumps with discharge nozzle sizes of 1 ½ in. and 2 in.

Type LR Single-Suction Single-Stage Pumps with a discharge nozzle of 2 ½ in.

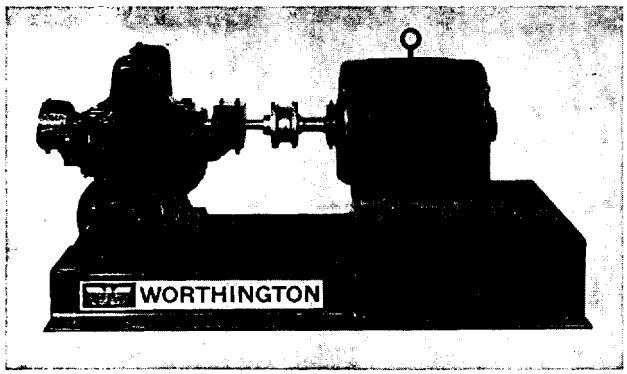
Type LRG Double-Suction Single-Stage Pumps with discharge nozzle sizes ranging from 4 to 8 in.

Type LR Double-Suction Single-Stage Pumps with discharge nozzle sizes ranging from 3 to 16 in.

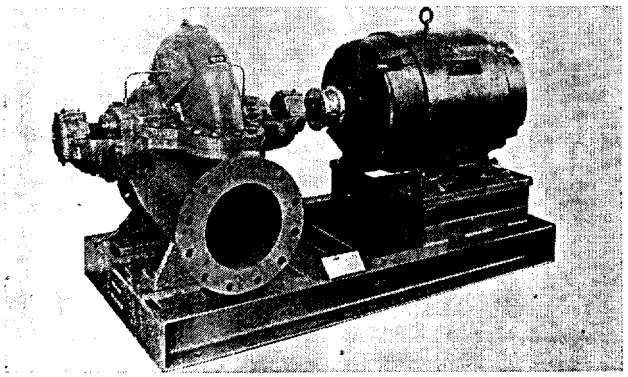
The three basic types are illustrated by the photographs and sectional drawings which are enclosed in this booklet.



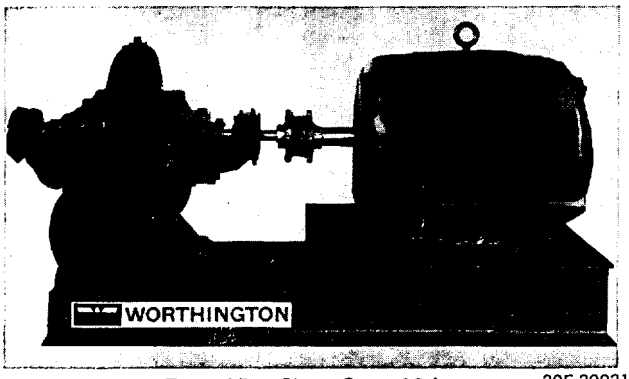
Type LLR—Sizes 1 ½ to 2 in. 20F-20020



Type LR—Size 2 ½ in. 20F-20023



Type LRG—Sizes 4 to 8 in. 20F-20130



Type LR—Sizes 3 to 16 in. 20F-20021

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SECTION I

INSTALLATION

INSPECTION OF EQUIPMENT

Immediately upon receipt of shipment, inspect and check the shipping manifest and report to the Transportation Company's local agent any damage or shortage.

Inspect the crate and wrappings before discarding. Parts or accessories are sometimes wrapped individually or fastened to the crate.

STORAGE

If the pump is received before site is ready, unit should be safely stored until it is needed. Storage can be considered short term or long term. Short term storage can be considered 90 days or less. During this time, pump should be preferably stored indoors in a dry environment away from any moisture. The service flanges on suction and discharge flanges should not be disturbed. Also, protective coatings particularly on the exposed shaft and coupling should not be removed. The bearings and couplings should be protected against inclusion of sand, grit, fly ash or other foreign matter. If there is presence of extreme moisture in environment, it is recommended that on pumps equipped with stainless steel shaft sleeves and graphite packing, gland be disassembled and packing be removed. Graphite in packing in conjunction with a film of moisture can cause electrolytic action to occur which would result in pitting of sleeves. This action does not occur under normal running operation.

Bearings on all LLR, LR and LRG pumps are grease lubrication unless otherwise ordered. No special precautions are needed on grease lubricated pumps for storage other than keeping moisture from entering the bearing housings. If moisture is present, bearing housings can be protected by applying a heavy fibrous grease between water shields and the bearing covers. On pumps equipped with oil lubrication, it is recommended that oil be placed in housing and rotor be turned over several times a month to insure bearings are thoroughly lubricated.

Long term storage. Storage beyond 90 days should be avoided. However, due to some circumstances, long term storage may be required. More precautions must be followed to avoid future troubles.

Pumps must be stored indoors in a dry environment away from any moisture. Pump should be flat on a pallet, if it is a bare pump, and not on its side or canted on shaft. Pump's internals must be protected from rusting. Pour in a water soluble rust preventative through casing vent holes until fluid appears at stuffing box openings. Turn rotor by hand so that running joints are fully coated. Fluid should be then drained from casing by opening drain holes in lower half of casing. Oil soluble rust preventative should be poured in the bearing housing and then drained.

CLEANING PRIOR TO INSTALLATION

If pump was flushed with rust preventative, it should be reflushed thoroughly with clean water. Drain any oil from bearing housing and relubricate according to lubrication instructions.

LOCATION OF PUMP

The unit should be so placed that it is accessible; pay due attention to the simplification of the suction and discharge piping layout. In general, and particularly when the influence of suction pipe losses is a vital factor, pumps should be installed close to the liquid supply. Limit the use of elbows, tees, and other fittings to a minimum.

In order to prevent distortion and misalignment, support and brace all piping to counteract strains due to weight and pipe expansions when heated.

When pumps are of large size, provide head room and lifting apparatus for overhaul. Motor driven units, when used in an unusually damp atmosphere, should be given special consideration.

SUCTION LIFT

In an ordinary individual pumping installation it is recommended that static suction lift not exceed 10 feet. Pipe friction, foot valves and strainer losses may amount to an additional 4 to 5 feet. If water is hot, suction life must be reduced. For example, water at 212° F must flow to pump under a net positive head of from 10 to 25 feet, depending on the many features involved in specific installation. Fire pumps should be provided with a head on suction, avoiding suction lifts, if possible. Operating suction lifts, including allowance for velocity and pipe friction loss and fitting losses, shall not exceed 15 feet at sea level.

NET POSITIVE SUCTION HEAD

The NPSH required varies with every size of pump and for any given pump it varies with the capacity. The NPSH

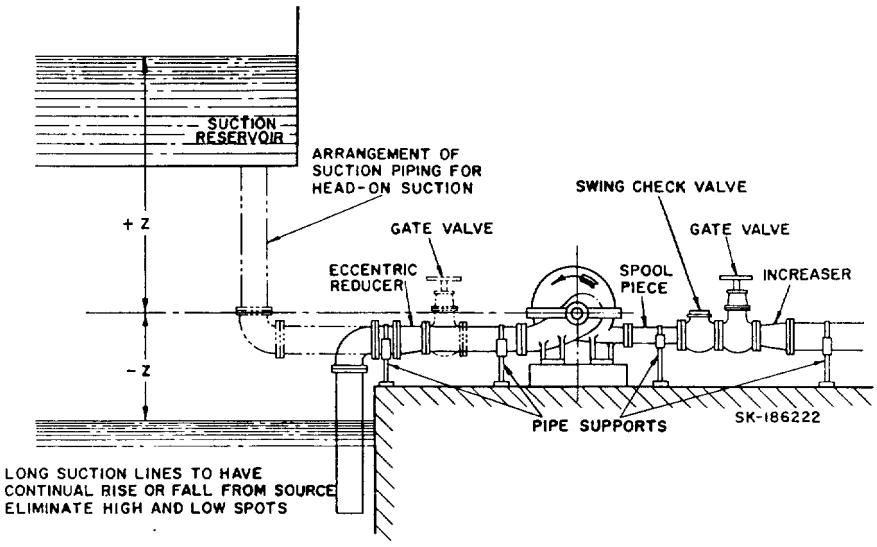


Fig. 1—LR, LLR and LRG Pumps Typical Piping Layout

required by your unit can be obtained from the performance curves available from your Worthington representative.

To determine the NPSH available in your system refer to Fig. 1 and the following equation:

$$\text{Available NPSH} = \pm Z + \frac{(P-P_v)\ 2.31}{\text{Sp. Gr.}} - H_f - H_e$$

Where Z = Static head in feet
P = Pressure on surface of liquid in psia
P_v = Vapor pressure of liquid at pumping temperature in psia
H_f = Suction line friction losses in feet
H_e = Entrance loss from tank to pipe in feet

NOTE: For boiling liquids, P equals P_v and this item can be omitted from the equation.

If the available NPSH is not equal to, or greater than, that required by the pump, it must be increased. This is usually done by increasing the static head, Z.

FOUNDATION

The foundation should be made to form a permanent, rigid support for pump, driver and baseplate. The baseplate should be mounted on a raised pedestal above the ground level to protect the motor and pump from possible flooding. A concrete pedestal foundation on a solid base should be satisfactory. The pedestal foundation should extend 9″ to 12″ beyond the baseplate; the top of the pedestal should be rough for grouting. When upper level installation is involved, the mounting arrangement should be made so that vibrational energy is not transmitted to the building structure. The isolation of vibration is achieved by placing steel springs between the pedestal, often referred to as inertia blocks, and the floor. The inertia block should be 1½ times the weight of the pump and its motor, but not less than 8″ thick. The isolation springs should be selected with not more than 1 or 2% transmissibility.

The purpose of foundation bolts is to anchor the pump unit to the foundation, or pedestal, so that the foundation and pump unit become a single structural unit. The foundation bolt should be enclosed in a pipe sleeve three or four diameters larger than the bolt. See Fig. 2 for a typical design. The pipe sleeve allows the bolt to be moved to compensate for slight errors in bolt location. The foundation bolts are held or supported by a wooden template or frame while the foundation is being built around them. The dimensions required to construct the frame or template should be obtained from the elevation drawing or by measuring the baseplate directly.

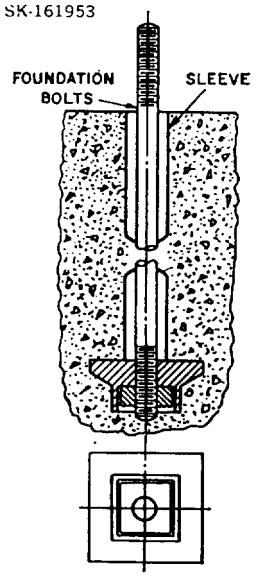


Fig. 2—Foundation Bolt

PIPING CONNECTIONS

Suction Piping—Experience has shown that the greatest amount of troubles with centrifugal pumps by far outside of misalignment, can be traced to a faulty suction line. We would emphasize that attention be given to this point when installing a pump. The suction piping should never be less in diameter than the full size of the pump suction opening. It should be as short and direct as possible. In cases where a long suction line can not be avoided, the size of the piping should be increased. Air pockets or high spots in a pump suction line will invariably cause trouble. The piping must be laid so as to provide a continual rise without high spots from the source of supply to the pump.

The suction pipe should project into the well or source of supply a sufficient amount to insure that the pipe is adequately submerged when the water is at its lowest level, with the pump operating. Large pipes are usually submerged four times their diameter while small pipes require from two to three feet submergence. The suction pipe should be blanked off and hydrostatically tested for air leaks before starting up.

Foot Valves are sometimes necessa. but they add to the suction-side frictional losses.

On important installations it is recommended that automatic priming apparatus be employed instead of foot valves unless the use of same is imperative. When a foot valve is used on the end of the suction pipe, care should be exercised in the selection of size and type in order to avoid disproportionate friction losses.

Strainer—When a strainer is placed in the suction pipe to prevent lodgment of foreign material in the impeller. it should have a net area of from three to four times the area of the suction pipe. The net area is understood to mean the clear and free opening through strainer. If the strainer is likely to become frequently clogged. an accessible place should be selected for the suction pipe. Twin strainers located accessibly are recommended. For large pumps. removable or mechanically operated screens should be placed at the entrance to the suction well.

NOTE: Strainers and other suction-side fittings should be installed as free as practicable from high spots in which air can accumulate.

Discharge Piping—The discharge piping should be selected with a diameter one size larger than the discharge opening of the pump if economically practical. It is very important that the pipe be independently supported near the pump so that no strains will be transmitted to the unit. External loads caused by the pipe cause misalignment with subsequent failure of bearings and internal parts. Provisions that are made for pipe expansion on hot services should also avoid placing strain on the pump.

A check valve and a gate valve should be installed near the pump outlet. The check valve provides protection from back flow. On units having no suction foot valve. the check valve eliminates the possibility of the pump rotating in the wrong direction if for any reason the driver ceases to function.

Before securing the piping, flush the pump and piping to be sure they are clear of foreign material. Also check

the flanges for both lateral and angular misalignment. Piping must be concentric and square before final bolting.

Drain Piping—All drain connections should be piped to a pump pit or suction well so that the drain water will be properly carried away.

MOUNTING AND ALIGNMENT

Shaft alignment is the most important consideration in pump installation. Pump-driver combinations are aligned at the factory, but baseplates can be sprung in shipment or distorted by unequal tightening of foundation bolts, so they must be checked before they are put in service.

Pumps on hot service must have final coupling alignment made with the unit at its operating temperature.

Pumps are generally shipped mounted, and it is usually unnecessary with units of moderate size to remove the pump or driver from its baseplate when leveling. The unit should be placed over the foundation supported by short strips of steel plate and wedges close to the foundation bolts, allowing for grouting from three quarters to two inches space between the bottom of the baseplate and the top of the foundation.

Remove coupling bolts before proceeding with leveling of unit and alignment of coupling halves.

Employing a small spirit level, the projecting edges of pads supporting pump and motor feet when scraped clean can be used for leveling the baseplate. Where possible, it is preferable to place the level on some exposed part of the pump shaft, sleeve or planed surface of casing. Adjust the wedges under baseplate till pump shaft is level and flanges of suction and discharge nozzles, vertical or horizontal as required, at same time observe that the pump is at the specified height, and location.

While proceeding with the leveling of pump and base, maintain at the same time accurate alignment of the unbolted coupling halves between pump and driver shafts.

Alignment—The procedure followed when checking driver and driver shaft alignment is as follows: Place a straight edge across the top and side of the coupling, and at the same time check the faces of the coupling halves for parallelism by means of a tapered thickness gauge or feeler gauges, as shown in Fig. 3 and 4.

When the peripheries of the coupling halves are true circles and of same diameter and the faces flat, exact alignment exists when the distance between the faces is the same at all points and a straight-edge will lie

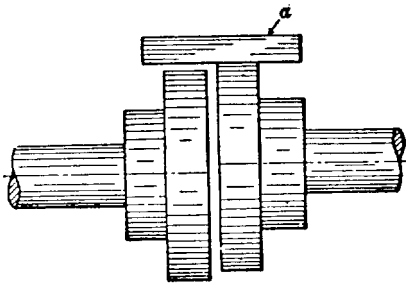


Fig. 3—Method of Checking Coupling Alignment.

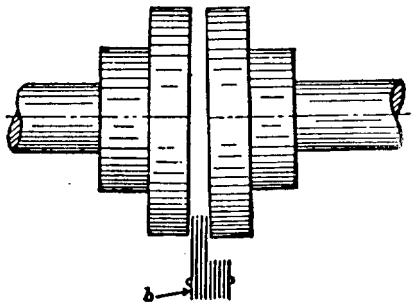


Fig. 4—Method of Checking Coupling Alignment.

squarely across the rims at any point. If the faces are not parallel, the thickness gauge or feelers will show a variation at different points. If one coupling is higher than the other, the amount may be determined by the straight-edge and feeler gauges.

Maximum coupling life with a minimum of maintenance may be obtained if the coupling is aligned properly at installation. Generally, permissible angular and parallel misalignment is .005″ for motors up to 75 hp and .010 for motors above 75 hp.

Steam turbines—In cases where pumps are driven by steam turbines, final alignment should be made with the driver heated to its operating temperature. Where this is not possible at the time of alignment, suitable allowance in the height of the turbine and shaft when cold should be made. Similarly, if the pump handles hot liquids, allowance must be made for the shaft being elevated when the pump expands. In any case the alignment should be checked when the unit is at operating temperature and adjusted as required before placing the pump in service. The application of heat to the steam and exhaust piping results in expansion, the installation must be so made that the turbine nozzles are not subjected to piping strains.

Space between faces of couplings—The clearance between the faces of couplings and the ends of shafts should be set so that they cannot touch, rub or exert a pull on either pump or driver. The amount of this clearance may vary with the size and type of coupling used. The best rule to follow is to allow sufficient clearance for unhampered endwise movement of the shafts of the driving element to the limit of its bearing clearance. On motor driven units, the magnetic center of the motor will determine the running position of the motor half coupling. It is recommended that this position be checked by operating the motor while disconnected. At this time, check also direction of rotation of motor. If current is not available, move motor shaft in both directions as far as bearings will permit then adjust shaft centrally between these limits, thereafter assembling the unit with the correct gap between coupling halves.

When the unit is accurately levelled and aligned, the holding down bolts should be gently and evenly tightened previous to grouting.

GROUTING

The purpose of grouting is to prevent lateral shifting of the baseplate, not to take up irregularities in the foundation. We recommend the following procedure:

The typical mixture for grouting-in a pump base is composed of one part pure portland cement and two parts building sand with sufficient water to cause the mixture to flow freely under the base.

The top of the rough concrete foundation should be well saturated with water before grouting. A wooden form should be built around the outside of the baseplate to contain the grout (Fig. 5). In some cases this form is placed tightly against the lower edge of the base, and in other cases it is placed a slight distance from the edge of the baseplate. Grout

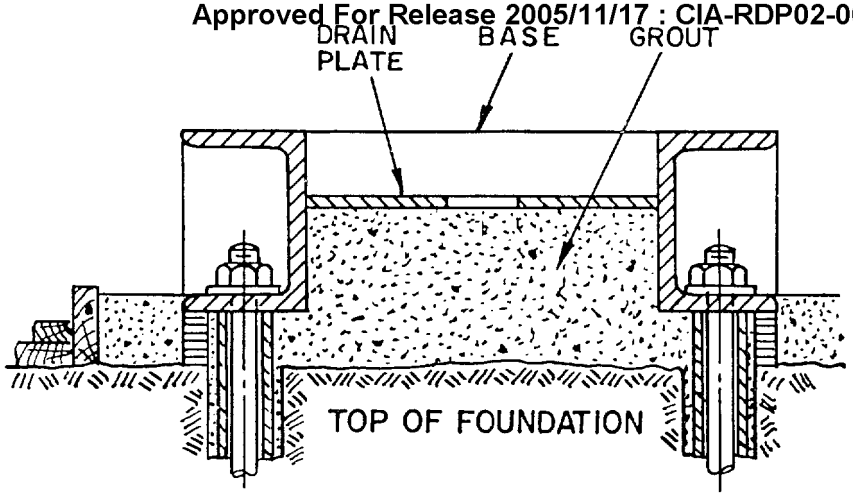


Fig. 5—Placing Form for Grouting SK-161970

is added until the entire space under the base is filled. The grout holes in the base are provided to serve as filling and vent holes. A stiff wire should be used to work the grout and release any air pockets.

After the grout is poured, the exposed surfaces should be covered with wet burlap to effect slow drying to prevent cracking. When the grout is set (about 48 hours) remove the forms and smooth the exposed surfaces, if desired. The grout should be hard in approximately 72 hours.

IMPORTANT: Alignment must be rechecked, after suction and discharge piping have been bolted to pump, to test the effect of piping strains. When handling hot liquids, the nozzle flanges, after the unit has been in service, should be disconnected to check in which direction the expansion of the piping is acting, correct for the effect of the strains as required.

An approved method for finally putting the coupling halves in alignment is by the use of a dial test indicator.

(1) Move the driver as required, including shimming front or back till the coupling faces are parallel.

(2) Bolt the indicator to the pump half of the coupling. With the button resting on the other coupling periphery, set the dial to zero and chalk mark the coupling half at the point where the button rests. For any check, top or bottom or sides, rotate both shafts by the same amount, i.e., all readings on the dial must be made with its button on the chalk mark.

The dial readings will indicate whether the driver has to be raised or lowered or moved to either side. After any movement, check that the coupling faces remain parallel to one another.

EXAMPLE: If the dial reading at the starting point is set to zero and the diametrically opposite reading at the bottom or sides shows a plus or minus .020-in. the driver has to be raised or lowered by shimming or moved to one side or the other by half of this reading.

NOTE: For all checks including that for parallelism of coupling faces, keep both shafts pressed hard over to one side when taking the readings.

SECTION II
OPERATION

DRIVER

For all driver information, reference should be made to the Manufacturer's Instruction Tag or Booklet attached to the unit or crate.

On motor driven units check motor characteristics on nameplate and connect wiring in accordance with attached instruction tag. Check rotation of shaft against direction arrow on pump casing.

PRIMING

A centrifugal pump should never be operated unless first filled with water, as in addition to the impossibility of pump delivering water when operated dry, wearing rings are likely to seize and cause serious damage. There are two methods to prime a pump when operating on a suction lift. The first method is to fill casing with water from some outside source until suction pipe and casing are completely filled with water. This method requires a foot valve installed on suction line. Care must be taken to exhaust all air from suction pipe and pump casing, as any air that remains entrapped will interfere with operation or hinder pump from lifting its water. On fire pump installations it is generally recommended to fill suction pipe and casing from a priming tank located above pump and connected to discharge side of pump before check valve.

The second method of priming a pump when operating on a suction lift is by use of an ejector or exhauster. The motive source can be steam, high-pressure water or compressed air. The ejector is usually attached to casing vent hole, however, on fire pump installations ejector is installed on line connected to discharge pipe before check valve. With this method of priming foot valves are not necessary. Priming may also be accomplished by use of a wet-type vacuum pump. The procedure is same as priming by ejector. Priming on pumps when operating on a positive head may be accomplished by opening suction valves and allowing casing to fill with liquid. Open vent valve on top of casing to release all entrapped air.

Preliminary to Starting—Read the instruction book thoroughly before starting the unit. Make sure the following items are checked before starting.

1. Alignment.

2. Check the direction of rotation of the driver with the coupling halves disconnected.

3. Check bearing lubrication as indicated in "Maintenance" section. Oil lubricated pumps are shipped from the factory without oil.

4. For pumps equipped with packed boxes, the gland nuts must be loose.

5. The pump must be filled with liquid. If a priming device is used, it must be operating before the pump is started.

Starting and operating—Connect a compound gauge to suction of pump and a pressure gauge to discharge flange of pump. Both flanges are drilled and tapped with 1/4-18 NPT. It is advisable to furnish shut-off valves between flange gauge connections and gauges. The gauges are necessary for an adequate check on pump performance.

Before starting and especially for the first time with oil-lubricated bearings, with the oil cold and bearing surfaces comparatively dry, it is important to revolve the rotor a few times either by hand or, with the pump filled with water, by momentarily operating the starting switch (if this procedure does not overload the motor). This starts a flow of oil to the bearing surfaces.

When the pump is full of liquid, suction valve open and the unit otherwise all ready, make a note of the vacuum or static pressure on suction gauge, start the driver and observe that the pump comes up to speed smoothly. (Pump may be operated for a few minutes with discharge gate valve closed without overheating or damage.) At this time a more extended tryout may be important in certain installations. When this is necessary keep the vent valves open to relieve pocketed air in the pump and system. This circulation of the water prevents the pump from becoming unduly heated.

When satisfied that the pump may be put in the line, close vent valves and open the discharge valve slowly. At this point if the absolute pressure on suction gauge shows a considerable drop compared to the pressure reading when the pump is at rest, or if discharge pressure does not register the moment the rotor is at or near operating speed, stop the driver and check up on all valve openings on suction side. Do not operate till certain there is a free and ample supply of water and no obstructions in piping.

In some installations after the first starting operation, the discharge line is full of liquid, this liquid on upper side of discharge check valve imposes a head on pump of sufficient magnitude for starting purposes. It is possible in these cases after priming or venting to fill casing with water, to start the pump with both suction and discharge gate valves open.

Bearings—The bearings should be carefully watched for signs of overheating.

Glands—The glands should be scrutinized to make sure that they are not cocked and rubbing on shaft sleeves, causing cutting, overheating and overloading of motor. Always allow a drip or small stream of water to issue from glands, this lubricates the packing which will burn if dry. A seepage rate of 60 drops/min. should assure proper packing lubrication.

Operating at low capacity—Do not operate a pump for long periods at low capacity on account of the possibility of overheating from churning. If this is necessary, install a permanent bypass from the discharge to the suction of a size equal to 1/5th the size of discharge pipe. Regulate this bypass for extreme low capacity operation. Be prepared to close the bypass by hand or automatically if there should be a demand for greater capacity.

Gland nuts to be loose at starting—With a low suction pressure, the glands should be left quite loose with most forms of packing, until the pump is in operation. This allows liquid to flow freely through the stuffing box; do not repack a stuffing box on account of a slight burning of the packing at starting unless absolutely necessary to keep down excessive gland leakage.

Stopping—Normally there is a check valve in the discharge line close to the pump. In such a case the pump can be shut down by stopping the motor. The valves should then be closed in the following order: discharge, suction, and any other connections leading to the pump or system.

Pumps can usually be stopped in this manner with the discharge gate valves open. In some installations, however, surges in the piping may impose heavy shocks on both lines and pump, when the flow of high-pressure water is arrested. In such cases, it is good practice to first shut the discharge gate valve, this entirely eliminates shock.

A pump will partly drain through the glands if left standing for some time and for this reason, always prime the pump at starting up.

If the pump is required for emergency use, and is always primed, it is not necessary to close suction and discharge valves. Under this condition, the glands may leak due to sustained pressure on a stationary shaft. Do not tighten the gland nuts unless prepared to loosen them again, at starting.

Centrifugal pumps should operate for long periods with practically no attention other than to observe that at all times there is a drip of liquid from the glands, and the bearings are properly lubricated.

Periodic examination—The pumps should be opened out for examination at intervals of about twelve months.

Pumps not in use—Rotors of pumps, for any reason not in service, should be revolved by hand or power once per week.

GALVANIC AND STRAY CURRENT CORROSION

If unusually rapid corrosion of pump parts is observed, the possibility of stray electric currents and galvanic corrosion should be investigated. For complete information on this subject refer to Worthite News Vol. 4 No. 3 available from your local Worthington representative.

CHECK LIST FOR OPERATING DIFFICULTIES

TEN SYMPTOMS	POSSIBLE CAUSE OF TROUBLE
Pump does not deliver water:	1- 2- 3- 4- 6-11-14-16-17-22-23
Insufficient capacity delivered:	2- 3- 4- 5- 6- 7- 8- 9-10-11-14-17-20-22 23-29-30-31
Insufficient pressure developed:	5-14-16-17-20-22-29-30-31
Pump loses prime after starting:	2- 3- 5- 6- 7- 8-11-12-13
Pump requires excessive power:	15-16-17-18-19-20-23-24-26-27-29-33-34-37
Stuffing box leaks excessively:	13-24-26-32-33-34-35-36-38-39-40
Packing has short life:	12-13-24-26-28-32-33-34-35-36-37-38-39-40
Pump vibrates or is noisy:	2- 3- 4- 9-10-11-21-23-24-25-26-27-28 30-35-36-41-42-43-44-45-46-47
Bearings have short life:	24-26-27-28-35-36-41-42-43-44-45-46-47
Pump overheats and seizes:	1- 4-21-22-24-27-28-35-36-41

FORTY-SEVEN POSSIBLE CAUSES OF TROUBLE

Suction Troubles

1. Pump not primed
2. Pump or suction pipe not completely filled with liquid
3. Suction lift too high
4. Insufficient margin between suction pressure and vapor pressure
5. Excessive amount of air or gas in liquid
6. Air pocket in suction line
7. Air leaks into suction line
8. Air leaks into pump through stuffing boxes
9. Foot valve too small
10. Foot valve partially clogged
11. Inlet of suction pipe insufficiently submerged
12. Water-seal pipe plugged
13. Seal cage improperly located in stuffing box, preventing sealing fluid entering space to form the seal

System Troubles

14. Speed too low
15. Speed too high
16. Wrong direction of rotation
17. Total head of system higher than design head of pump
18. Total head of system lower than pump design head
19. Specific gravity of liquid different from design
20. Viscosity of liquid differs from that for which designed
21. Operation at very low capacity
22. Parallel operation of pumps unsuitable for such operation

Mechanical Troubles

23. Foreign matter in impeller
24. Misalignment
25. Foundations not rigid
26. Shaft bent
27. Rotating part rubbing on stationary part
28. Bearings worn
29. Wearing rings worn
30. Impeller damaged
31. Casing gasket defective permitting internal leakage
32. Shaft or shaft sleeves worn or scored at the packing
33. Packing improperly installed
34. Incorrect type of packing for operating conditions
35. Shaft running off center because of worn bearings or misalignment
36. Rotor out of balance resulting in vibration
37. Gland too tight resulting in no flow of liquid to lubricate packing
38. Failure to provide cooling liquid to water-cooled stuffing boxes
39. Excessive clearance at bottom of stuffing box between shaft and casing, causing packing to be forced into pump interior
40. Dirt or grit in sealing liquid, leading to scoring of shaft or shaft sleeve
41. Excessive thrust caused by a mechanical failure inside the pump or by the failure of the hydraulic balancing device, if any
42. Excessive grease or oil in antifriction-bearing housing or lack of cooling, causing excessive bearing temperature
43. Lack of lubrication
44. Improper installation of antifriction bearings (damage during assembly, incorrect assembly of stacked bearings, use of unmatched bearings as a pair, etc.)
45. Dirt getting into bearings
46. Rusting of bearings due to water getting into housing
47. Excessive cooling of water-cooled bearing resulting in condensation in the bearing housing of moisture from the atmosphere

SECTION III
MAINTENANCE

BEARING LUBRICATION—GENERAL

Bearing Bracket Design—The bearing brackets on all LR, LLR & LRG pumps are designed so the lubricant can be changed from grease to oil or vice versa by making several minor changes. The same bearing brackets are used for oil and grease. All pumps are shipped from the factory with grease-lubricated bearings unless the order specifies oil lubrication. To convert from grease to oil or oil to grease follow the instructions listed under "Method of Converting Bearing Housings From Grease to Oil Lubrication." Grease fittings are furnished with grease lubricated pumps. Oil lubricated units have oilers and vent caps. All bearing brackets are equipped with ¼ in. drain plugs.

Oil vs. Grease—Either oil or grease can satisfactorily lubricate the bearings. Neither one is more suitable as a lubricant than the other. The choice depends upon the particular pump installation and the conditions of service. The advantages and disadvantages of oil and grease are listed as follows:

FACTOR	OIL PREFERRED	GREASE PREFERRED
1. Ease of draining, cleaning and refilling.	X	
2. High liquid temperature.	X	
3. Low liquid temperature.		X
4. High speed.	X	
5. Protection against contamination.		X
6. Possibility of leakage.		X
7. Ease of controlling the correct amount of lubricant.	X	

Bearing Temperature—Ball bearings are very sensitive to over lubrication and under lubrication, both being detrimental to bearing performance. In either case, excessive heating and reduced life will result. To determine the approximate bearing temperature, use a thermometer and a piece of putty. Place the bulb of the thermometer on the bearing bracket housing at a convenient point and place the putty over the bulb. Record the temperature reading after the temperature stabilizes. The temperature measured by this method will be less than the actual bearing temperature because a temperature drop will occur between the bearing and the point of measurement. The ball bearings furnished on LR, LRR & LRG pumps will operate satisfactorily at temperatures up to 280 F provided the lubrication is adequate. A safe maximum temperature is 225 F. The operating temperature of the bearing will vary considerably with the room temperature and the temperature of the liquid pumped. Oil-lubricated bearings will run slightly hotter, since oil tends to dissipate the heat more readily than grease. The thrust bearings on LLR pumps will run hotter than the line bearings since the losses with an angular contact type bearing is greater.

Cleaning—General—All lubricants have a tendency to deteriorate in the course of time, but at a different rate. Therefore, a complete change of lubricant and cleaning of the housing and bearings is necessary to obtain maximum life from the bearings. The lubricant should be removed in the early stages of deterioration in order to prevent trouble. Bearings which are dismantled are more easily and thoroughly cleaned, but the dismantling is not practical unless the pump is to be overhauled. The bearings can be cleaned in position by the following method:

Cleaning—Mounted Bearings—Bearings can be cleaned without dismounting by flushing the housing with hot, light oil at 180 F to 200 F. Use a light oil not heavier than SAE 10. Rotate the pump shaft slowly to remove grease and deposits.

For grease lubricated bearings, the housings should be purged with fresh grease before starting to remove any remaining oil. Run the pump for an hour without the drain plugs and let the excess grease drain out. This will prevent the bearings from overheating due to excess grease.

Cleaning Schedule—Bearings subjected to high operating temperatures require more frequent cleanings to assure freedom from deposits. The bearings should be cleaned at periodic intervals depending on the type of service and the lubrication schedule.

Grease-lubricated bearings should be cleaned at least once a year. Oil-lubricated bearings should be cleaned at every oil change.

Method of Converting from Grease to Oil Lubrication—Grease lubricated bearings are supplied on all standard pumps.

It is possible to convert to oil lubrication by making several minor modifications which are listed as follows:

1. Remove all grease from the bearings and the bearing bracket housings by following the instructions listed under "Cleaning—Mounted Bearings".

2. Remove "Zerk" grease fittings and plug the openings with a ¼-28NF screw ¼ in. long.

3. Remove ¼ in. pipe plugs from the sides of the housings and install oilers.

4. Remove the ¼ in. pipe plugs from the top of the housing and install vent caps.

5. Fill the housings with oil as outlined under "Instructions for Filling Oil Reservoir".

To change from oil to grease, reverse the above procedure.

GREASE LUBRICATION

Starting New Pumps—All LR, LLR & LRG pumps with grease-lubricated bearings are greased at the factory. As a secondary precaution, regrease the bearings before starting the unit so as to insure proper lubrication.

Lubrication Schedule—Grease-lubricated bearings should have grease added every 1,000 to 2,000 hr., depending on both the severity of the service and the surroundings. For

pumps operating continuously 24 hr./day, this would be every 6 to 12 weeks. For pumps on 8 hr., 5 days/wk., this would be 6 to 12 months. Pumps on less frequent or intermittent duty should be greased once each year or two.

Grease Specifications—Grease is a mixture of lubricating oil and a soap base that keeps the oil in suspension. Classification is usually according to the soap base material, consistency and additives. For pump bearings, a moisture-resistant grease of No. 2 consistency that contains a rust inhibitor is recommended. For bearing temperatures up to about 150 F., the base should be lime; for temperatures over 150 F., it should be lithium.

Over and Under Lubrication—Care must be taken to avoid both under and over-lubrication. While neglected bearings could fair prematurely from contaminated old grease, the too-frequent addition of grease increases the friction in the bearings and could also cause failure. Because the bearing grease is out sight, this over lubrication can be a real danger. Over-lubrication will cause the bearings to run hotter than normal. To remedy this condition, remove the ¼ in. drain plugs from the bottom of the housings and let the excess grease drain out while the pump is running. The temperature should stabilize after the pump is run for awhile. If the heating persists, refer to instructions on coupling and piping alignment.

Greasing Instructions—The AFBMA recommends that ⅓ to ½ of the volume in the housing should be filled with grease for normal applications. This will give the most ideal operating conditions. The following greasing procedure is recommended: Remove the ¼ in. pipe plugs from the top and bottom of both bearing brackets. While the pump is running, force new grease through the grease fittings until there is visual evidence that grease has been forced thru the bearing. If necessary, shine a light into the housing thru the opening on the top so that a visual observation can be made. As soon as grease is forced thru the bearing do not add any more. In the event that too much grease has been added, let the pump run awhile without the plugs until all of the excess grease has been expelled.

OIL LUBRICATION

Lubrication System—The bearings on oil lubricated pumps are lubricated by the method of flood oiling (Fig. 6). The oil is maintained so that the bottom ball in the bearing is submerged in the oil about half way. A constant level Trico Oiler automatically maintains the correct oil level. The Trico Oiler furnished has a set screw adjustment for raising or lowering the level. The adjustment range is 19/32 in. The bottle should be adjusted so that it is in the lowest position. The oil level will then be exactly at the center of the bottom ball bearing. This will give the most optimum operating conditions.

Instructions for Filling Oil Reservoir—Unscrew the plastic bottles from the oil reservoir, then fill with the proper grade of oil and replace. Allow the oil to flow until the oil level in the bottle reaches and maintains a constant level. Make sure the bottle is in the lowest position while filling so that the correct amount of oil is poured in. On some pumps, it may be necessary to refill the bottle a second time. Do not fill through the air vent opening in the top of the housing because too much oil may be added. This will cause the bearings to overheat. Also, oil may leak out at the annular clearance between the shaft and the bearing cover.

When the level is reached and no more oil runs out of the bottle, the pump may be started. The oil in the bottle must be visible at all times. From time to time, it may be necessary to add more oil.

Starting New Pumps—Before starting, the oil reservoirs must be filled with oil as outlined under "Instructions for Filling Oil Reservoir". Make sure that the proper grade of oil is used.

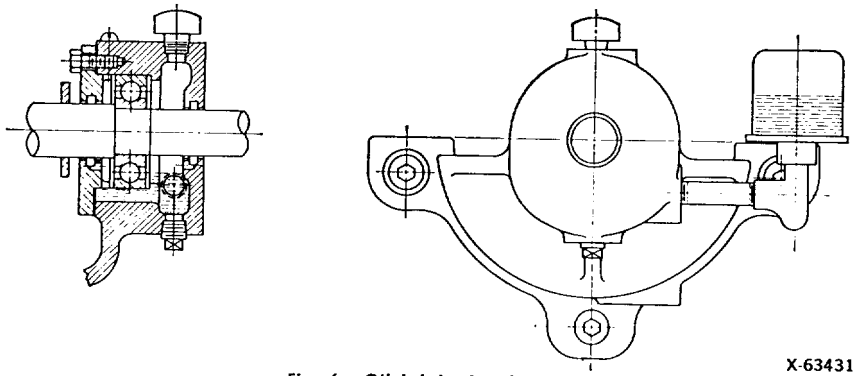
The bearings are shipped from the factory with a slushing compound which serves as a rust preventative.

Grade of Oil—Use of a high quality lubricating oil containing rust, oxidation and foam inhibitors. Such oils are often referred to as turbine and/or hydraulic oils. To select oil of the proper viscosity, the actual operating temperature of the bearings must be measured or approximated from experience. Bearing temperatures can be measured as indicated in section titled "Bearing Temperature". The following chart lists the recommended viscosity for different bearing temperatures.

Bearing Temp., F.	Viscosity, SSU. * at 100 F.	SAE No.
0 to 125	75	5W
126 to 145	150	10W
146 to 180	300	20
180 to 200	700	30

*SSU is Saybolt Seconds Universal.

Oil Changes—For normal 8 hour duty, change the oil approximately every 6 months. For pumps on hot service or in a damp or corrosive atmosphere change the oil more frequently.



X-63431

Fig. 6—Oil Lubrication System

STUFFING BOXES—PACKED

Type of Packing—Die-moulded packing equivalent to Ace-O-Pak 14 is furnished on all standard pumps unless the order specifically calls for a special packing. For special applications, we also furnish other types of packing which are listed in Fig. 6a. Special hardened shafts or sleeves are required for certain types of packing. For special applications not listed, consult a reputable packing manufacturer or Worthington.

Packing and shaft sleeve recommendations for centrifugal pumps handling clear cold water.

Temperature Range Degrees Fahrenheit	Stuffing Box Pressure (usually pump inlet pressure)	Packing Specification	Shaft Sleeve		
			Material	Minimum Hardness Brinell	Surface Finish Maximum Micro-Inches
To 212 F	To 30 psig	Equal to *Ace-O-Pax No. 14 packing	Bronze, steel, etc.	75	40
To 212 F	30-150 psig	Equal to *Ace-O-Pax No. 90-620 BM packing	Hardened 420 chrome steel	550	16
212-250 F	To 75 psig	Equal to *Ace-O-Pax No. 90-620 BM packing	Hardened 420 chrome steel	550	16
212-250 F	75-150 psig	Equal to *Ace-O-Pax No. 1700-620B packing	Colmonoy No. 6 or equal coating on stainless steel	600	10

Ace-O-Pax is manufactured by the Packing Engineering Corporation, Cranford, N.J.

Ace-O-Pax Style No. 14—This is a braid over braid asbestos packing lubricated with a high melting point mineral oil and wax for general services.

Ace-O-Pax Style No. 90-620BM—This is a combination of two packings. Ace-O-Pax No. 90, Non-Metallic packing containing long fiber asbestos, finished with Mica; and Style No. 620BM Flexible Metallic Foil packing containing multiple strands of lead alloy also finished with Mica.

Ace-O-Pax Style No. 1700-620B—This is a combination of two packings. Style No. 1700 Rubber bonded Semi-Metallic Plastic packing (approved by the U.S. Navy for boiler feed purposes), and Style No. 620B constructed of a central asbestos core, about which are spiraled a number of lead alloy metallic strands, longitudinally folded, but not containing individual cores.

NOTE: The above recommendations should not be interpreted to mean that packing is recommended rather than a mechanical shaft seal, but only to indicate what packing and sleeve combination is recommended if packing is desired.

Fig. 6a—Packing and Shaft Sleeve Recommendations

Seal Cages & Seal Cage Water Connections—Stuffing boxes are equipped with seal cages which can be used to bleed water to the packing. The water provides cooling and lubrication, and also prevents air leakage into the pump when the suction pressure is less than atmospheric. Also, when a independent source of sealing water is used, it is possible to flush the packing of any grit or solids handled by the pump. If required, sealing water can be supplied to the stuffing box seal cages by two methods:

1. By injecting water from an independent source at a pressure approximately 5 to 10 psi higher than suction pressure.

2. By the use of seal tubes connected to the pump volute. This method is standard for LRG pumps.

The method employed should conform with the instructions in Fig. 7 and 8.

Stuffing Box Arrangement—Depending on the conditions of service there are several possible stuffing box arrangements as shown in Fig. 8. All standard pumps are furnished with a stuffing box arrangement as follows:

The water connections at the stuffing box are plugged at the factory with ¼ pipe plugs. Seal tubes and compression couplings are shipped with the pump in a separate envelope. In order to obtain maximum packing life and to avoid stuffing box trouble, it is recommended that the stuffing box arrangement correspond to the actual conditions of service as indicated in Fig. 7.

Packing Replacement—We recommend the use of pre-cut die-moulded or mandril-cut packing. To install new packing, first remove the old packing with a suitable packing puller. Make sure that the packing to be installed is of the proper grade. See Fig. 6a for packing recommendations. If in doubt, contact Worthington or a reputable packing manufacturer. Insert one packing ring at a time into the stuffing box by means of the gland. The spit of successive packing rings should be placed 90 degrees apart. If seal cages are used, make sure the cages are installed in the right location. The seal cages should be directly under the tapped opening in the stuffing box on the upper half of the casing. Also, on some types of packing sets alternate rings are of different material. For example, refer to Fig. 8a which shows the correct arrangement for No. 90-620BM Packing. It is important that the rings are installed in the correct location.

When installing the gland, tighten the gland nuts finger tight. Do not over tighten with a wrench.

Packing Adjustment—General — In order to assure proper packing lubrication, a leakage rate of 60 drops per minute is required. If the stuffing box leakage rate is too high, tighten each hexagon gland nut only one flat or one sixth of a turn. Wait for about ten minutes until the packing seats itself. After ten minutes, if the leakage rate is still too high, tighten the nuts another one sixth of a turn. Do not overtighten the nuts

Pump	Stuffing Box	Arrangement
LR (Sizes 2½ to 16 in.) except 2½ LR-10	Both Sides	A
2½ LR-10	Both Sides	E
LR (Sizes 1½ and 2 in.)	Suction Side	E
LLR (Sizes 1½ and 2 in.)	Discharge Side	H
LRG (Sizes 4 to 8 in.)	Both Sides	B

to the point where all leakage is stopped.

Operation of the pump without stuffing box leakage will cause the packing to burn up. Also, the shaft or shaft sleeve will be scored and the horsepower required to drive the pump will increase.

Packing Adjustment—Start-Up — If the glands are tightened to prevent leakage when the pump is shut down, make sure the gland nuts are loosened before the pump is started again. Many operators forget to loosen the nuts before starting. This is a common cause of packing and shaft or sleeve failure.

STUFFING BOXES—MECHANICAL SEALS

Type of Seals—When seals are required, John Crane type I mechanical seals are furnished as standard on all LR & LLR pumps. Nomenclature of these seals are as follows:

Standard Fitted	All Iron	Bronze
BP-271	BP-1I71	BP-1C1
BP-2C1	BP-1C1	BP-1D1
	BP-1D1	
BP-2D1		

The maximum pressure and temperature for the above seals is 150 psi and 180°F. For temperatures and pressures higher than these, consult the factory. The gland furnished with these seals is a combination plain or flush type. If flush is specified, remove the pipe plugs from the side of gland and connect tubing from the casing volute to the gland as shown on Fig. 8b. However, if the liquid being pumped contains mud, grit, sand or abrasives, it is strongly recommended to inject clean water into the gland at a pressure slightly higher than suction pressure. The flushing action will tend to move away from critical seal faces any debris and oxides which are normally found in a new installation.

Parts Required for Converting Stuffing Boxes from Packing to Mechanical Seals:

To convert from packing to John Crane Type 1 Seals the following parts are required:

Two Mechanical Seal Glands
Four Gland Bolts
Two "O" Rings for Glands
Two Collars with Set Screws
Two Mechanical Seals

Procedure for Converting Stuffing Boxes from Packing to Mechanical Seals:

The procedure for installing mechanical seals is as follows:

1. Perform operations (1) to (10) listed in section titled "Dismantling Procedure".

2. Install the mechanical seal parts on the rotor as shown in Fig. 7b. Do not lock the collars to the shaft or sleeve.

3. Install the water shield, bearing cover and bearing on both line and thrust end.

4. Install the bearing cover gaskets and the bearing housings.

5. Remove the gland studs from the casing lower half.

6. Install the rotor in the lower half and bolt the bearing housings to the casing.

7. Position the seal collar in the correct position as indicated by the "Z" dimension.

8. Install the casing upper half and bolt-up completely.

Nature of Liquid Pumped	Temperature	Suction Pressure	LR Sizes 2½ to 16 in. (except 2½LR-10) Both Sides	2½LR-10 Both Sides	LLR Suction Side	LLR Discharge Side
Clear Liquid	250 F or less	5 psig to 25 psig	A or D	E or H	E or H	H
Clear Liquid		25 psi or higher	D	H	H	H
Clear Liquid		5 psig or less	B	F	G	H
Liquid with Mud, Sand, Grit or Abrasives		negative or positive	C	G	G	G
Liquid with Non-Lubricating Quality; dilution by seal water will not cause excessive dilution or reaction with the liquid pumped		negative or positive	C	G	G	G
Condenser Hotwell Water		Less than atmospheric	C	G	G	G

Fig. 7—Recommended Stuffing Box Arrangement (See top of page 14)

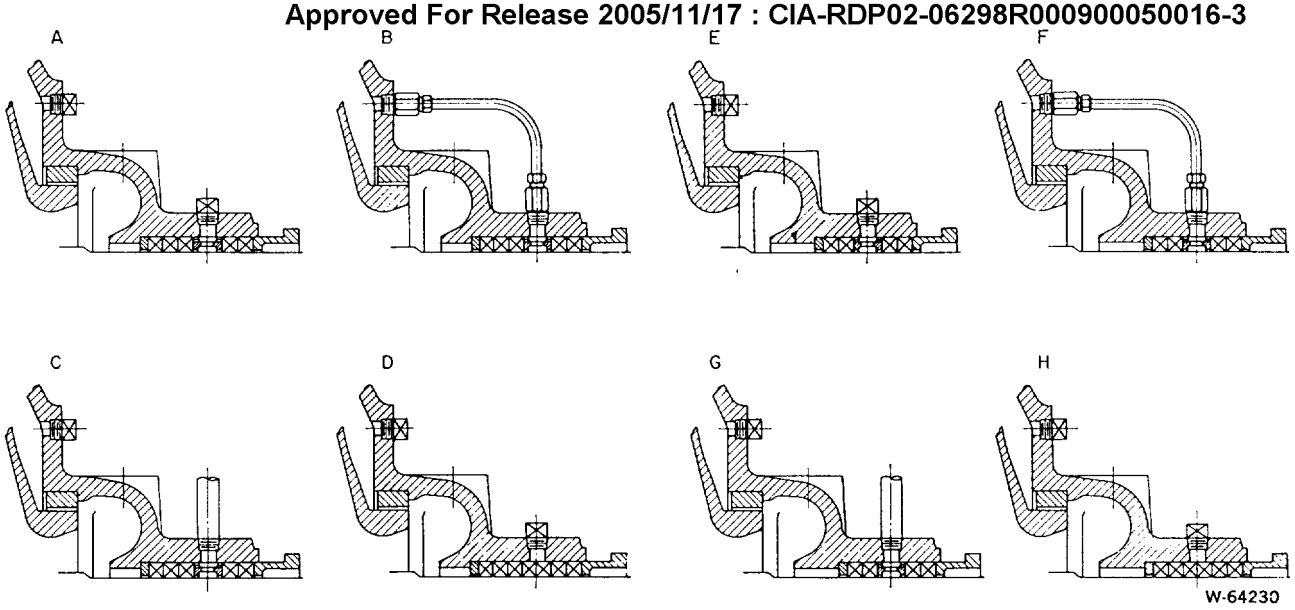
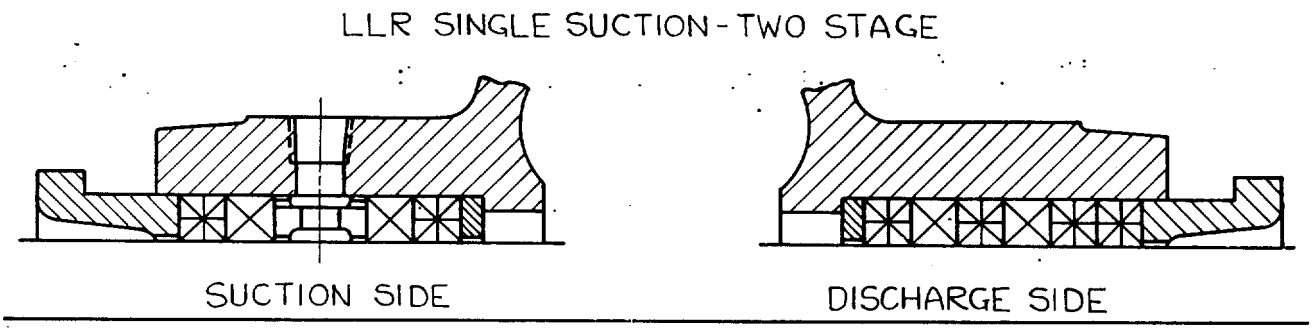


Fig. 8—Possible Stuffing Box Arrangements for LR & LLR Pumps



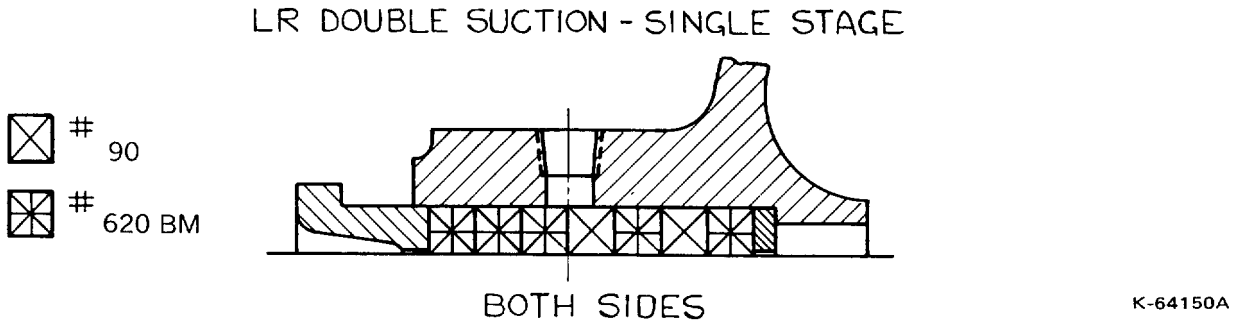
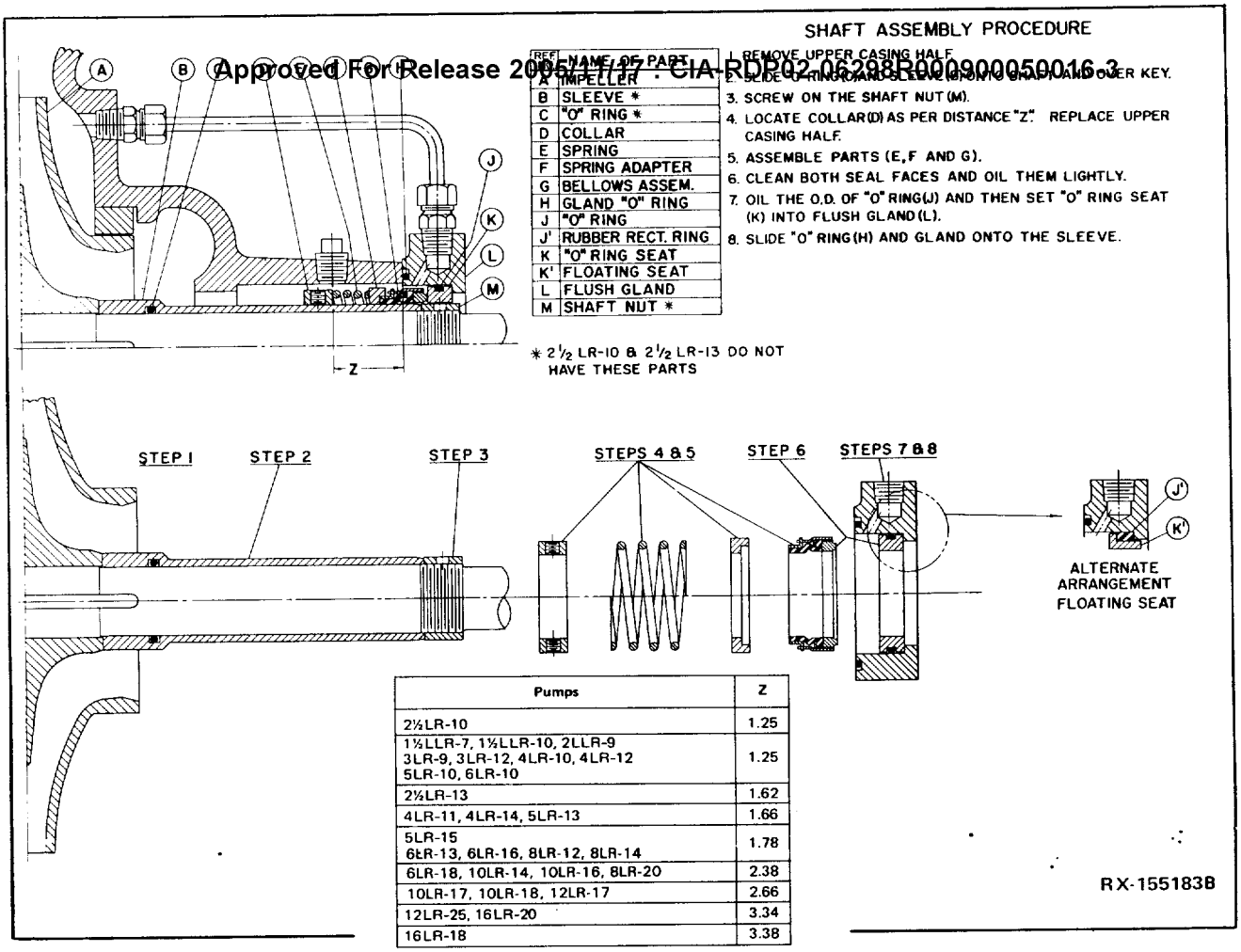


Fig. 8a—Stuffing Box Arrangement for Ace-O-Pax No. 90-620BM Packing



Pumps	Z
2½LR-10	1.25
1½LLR-7, 1½LLR-10, 2LLR-9 3LR-9, 3LR-12, 4LR-10, 4LR-12 5LR-10, 6LR-10	1.25
2½LR-13	1.62
4LR-11, 4LR-14, 5LR-13	1.66
5LR-15 6LR-13, 6LR-16, 8LR-12, 8LR-14	1.78
6LR-18, 10LR-14, 10LR-16, 8LR-20	2.38
10LR-17, 10LR-18, 12LR-17	2.66
12LR-25, 16LR-20	3.34
16LR-18	3.38

Fig. 8b—Typical Crane Seal Installation Procedure for LR and LLR Pumps

BEARING INTERCHANGEABILITY CHART

Pump Size and Type	Ball Bearing Numbers							
	SKF		Fafnir		New Departure		MRC	
	Thrust	Line	Thrust	Line	Thrust	Line	Thrust	Line
1½LLR-7, 1½LLR-10, 2LLR-9	7305BGY	6305	7305WSU	305K	——	3305	——	305S
2½LR-10	5305	6305	5305K	305K	5305	3305	5305SB	305S
2½LR-13, 4LR-11, 4LRG-11, 4LR-14, 5LR-13, 5LRG-13	6306	6306	306K	306K	3306	3306	306S	306S
3LR-9, 3LR-12, 4LR-10, 4LR-12, 4LRG-12, 5LR-10, 6LR-10	6305	6305	305K	305K	3305	3305	305S	305S
5LR-15, 5LRG-16, 5LRG-19, 6LR-13, 6LR-16, 8LR-12, 8LRG-14	6406	6308	406H	308K	3406	3308	406S	308S
6LR-18, 6LRG-18, 8LRG-20, 8LR-20, 10LR-14, 10LR-16, 12LR-17	6309	6211	309K	211K	3309	3211	309S	211S
10LR-17, 10LR-18, 16LR-18	6213	6213	213K	213K	3213	3213	213S	213S
12LR-25	6217	6217	217K	217K	3217	3217	217S	217S
16LR-20	6314	6314	314K	314K	3314	3314	314S	314S

Fig. 8c

REPAIR INSTRUCTIONS

DISMANTLING PROCEDURE

Great care must be exercised in the dismantling operation. Close the suction and discharge valves and drain the liquid from the casing.

NOTE: When dismantling, for convenience at reassembly, lay out all parts in the order in which they are removed. Protect all machined faces against metal-to-metal contact and corrosion.

Proceed as follows:

(1) If bearings are oil lubricated, drain housings and remove oilers.
(2) Disconnect the coupling halves. If oil-lubricated couplings are used, drain the oil before unbolting.
(3) Disconnect glands from casing by unscrewing nuts from gland studs. If glands are of the split type, remove completely. (Split glands are standard on LRG pumps.)
(4) With a suitable punch, drive out the two straight roll pins which are used at the horizontal split to align the upper and lower casing half.
(5) Remove the bolts which hold the upper and lower half of the casing together and remove the upper half as described under section titled "Method of Lifting Casing Upper Half"
(6) Remove the three bolts on both sides of the pump which hold the bearing housing bracket to the casing. Remove dowel bushings as indicated under section titled "Method of Removing Dowel Bushings".
(7) Lift out rotor assembly. Use care in slinging and handling of the rotor.
(8) Loosen bearing covers and remove bearing housing.
(9) Remove ball bearings and covers.
(10) Remove glands, packing and seal cages.
(11) Remove shaft sleeve nuts and shaft sleeves.
(12) Remove impeller, casing rings and impeller key.

As the pump and rotor are dismantled, all individual parts, all important joints and all wearing surfaces should be carefully examined.

As a general rule, regardless of the performance of the unit, parts appreciably worn should be renewed if it is not intended to examine the pump until the next overhaul period. It should be remembered that when parts (in new or good condition) with metal seats are assembled in contact with dirty or worn parts, the new parts are very likely to wear out rapidly.

Method of Removing Dowel Bushings —As shown in the sectional drawings, accurate alignment between the casing and brackets is obtained with the use of straight hollow dowel bushings. Two dowel bushings are used on each bearing housing bracket. A tool for removing the dowel bushings can be made very easily and cheaply as indicated in Fig. 10. The dowel bushings have internal threads (5/8 *D* 11-NC) which are used for pulling the dowels. See Fig. 10 which shows the Dowel Bushing Puller installed in position. With the puller installed in position as shown, tighten the hexagon head bolt to remove dowels.

Dowel bushings are made from a corrosion resistant steel. Before reinstalling the bushings, coat the O.D. with pipe compound. This will make it easier to remove the bushings the next time the pump is dismantled.

*Method of Lifting Casing Upper Half

To lift the casing upper half remove the pipe plug or fittings, if used, from the volute vent connection located on the top of the casing upper half. Install one of the following lifting devices:

a) Special steel eye bolt with a threaded shank to match the pipe top opening in the casing,

b) Steel nipple and tee with a steel bar inserted thru the open ends of the tee for the sling attachment.

**Use eyebolts installed in upper half on 12 & 16 LR pumps.*

ASSEMBLING

To assemble the pump reverse the dismantling procedure previously described, except for packing and seal cage instructions.

Before bolting the bearing housing brackets to the casing, coat the faces of the brackets with shellac or permatex. This will prevent leakage from the stuffing box from leaking thru the joint where the bracket joins the casing.

NOTE: When re-assembling the impeller on the shaft, it is important to mount the impeller so that the vane tips point away from the apparent flow direction. The rotor always rotates toward expanding sections of the volute.

Install the rotor in the casing and check to see that the rotor turns freely by hand. Wearing surfaces at the impeller must not touch. Align the pump carefully. Install packing and seal cage (see packing procedure).

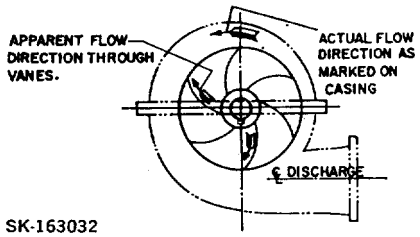
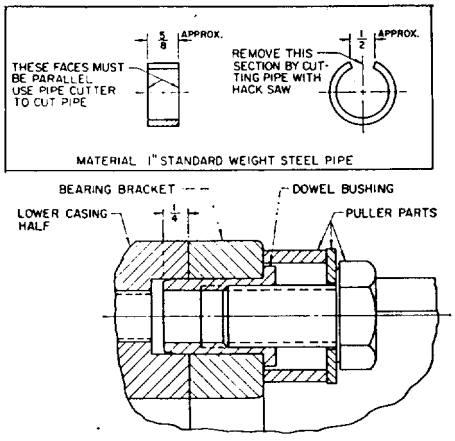


Fig. 9—Direction of Impeller Rotation



PARTS FOR DOWEL BUSHING PULLER:
ONE 5/8"D-11NC HEXAGON HEAD BOLT 1 1/8" LONG
ONE S.A.E. STANDARD PLAIN FLAT WASHER 25/32" I.D. X 1 5/16" O.D.
ONE SLEEVE AS INDICATED BY SKETCH

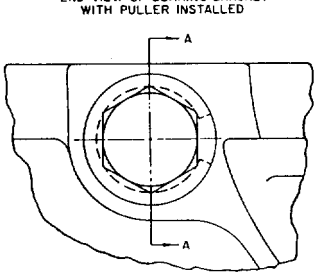


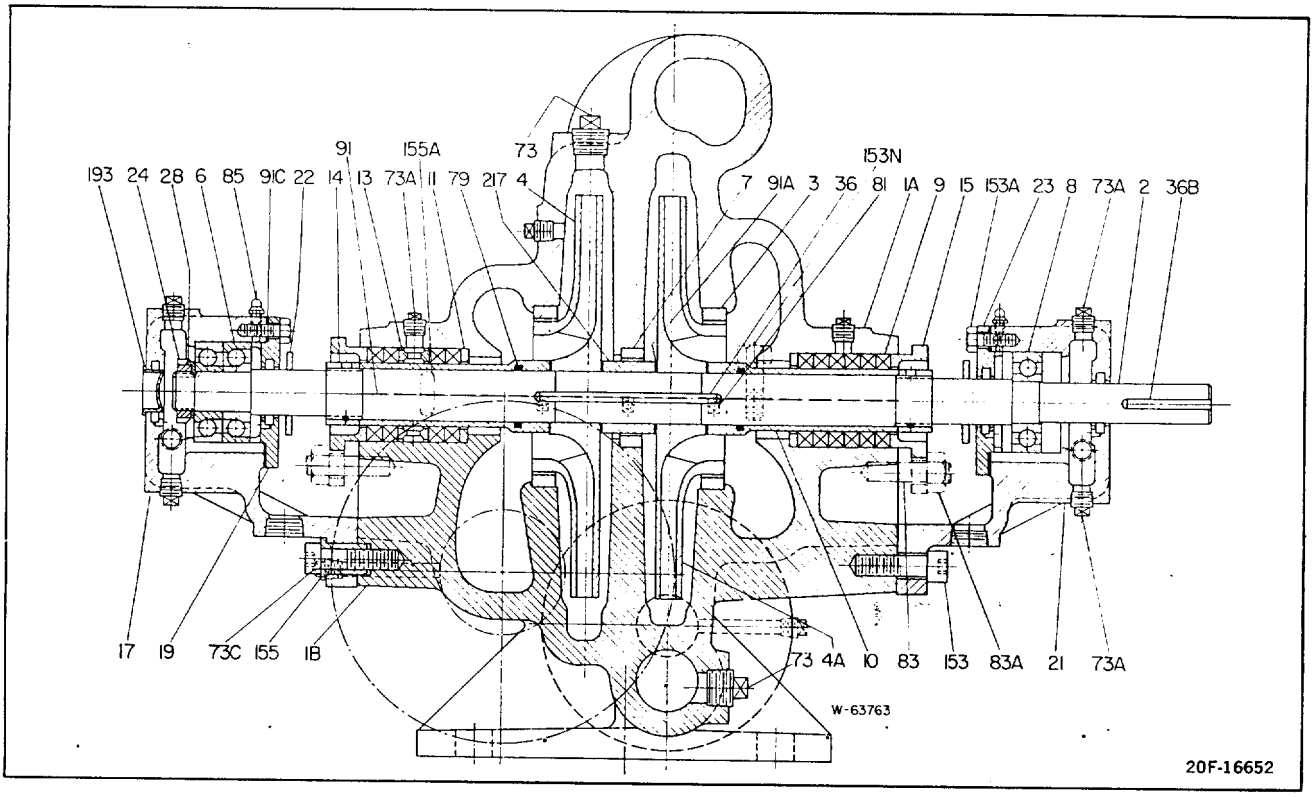
Fig. 10—Dowel Bushing Puller

ORDERING REPAIR PARTS

When ordering repair parts always give the SERIAL NO. and SIZE of PUMP, stamped on nameplate. Itemize each part required using the Reference No. and Name of Part given in the cross-section drawing that applies to your pump. Be sure to state the number of pieces desired.

If the repair parts are to be made of a different material than was originally furnished, a full explanation of the reasons for the change should be given.

TYPE LLR CENTRIFUGAL PUMPS
PARTS LIST



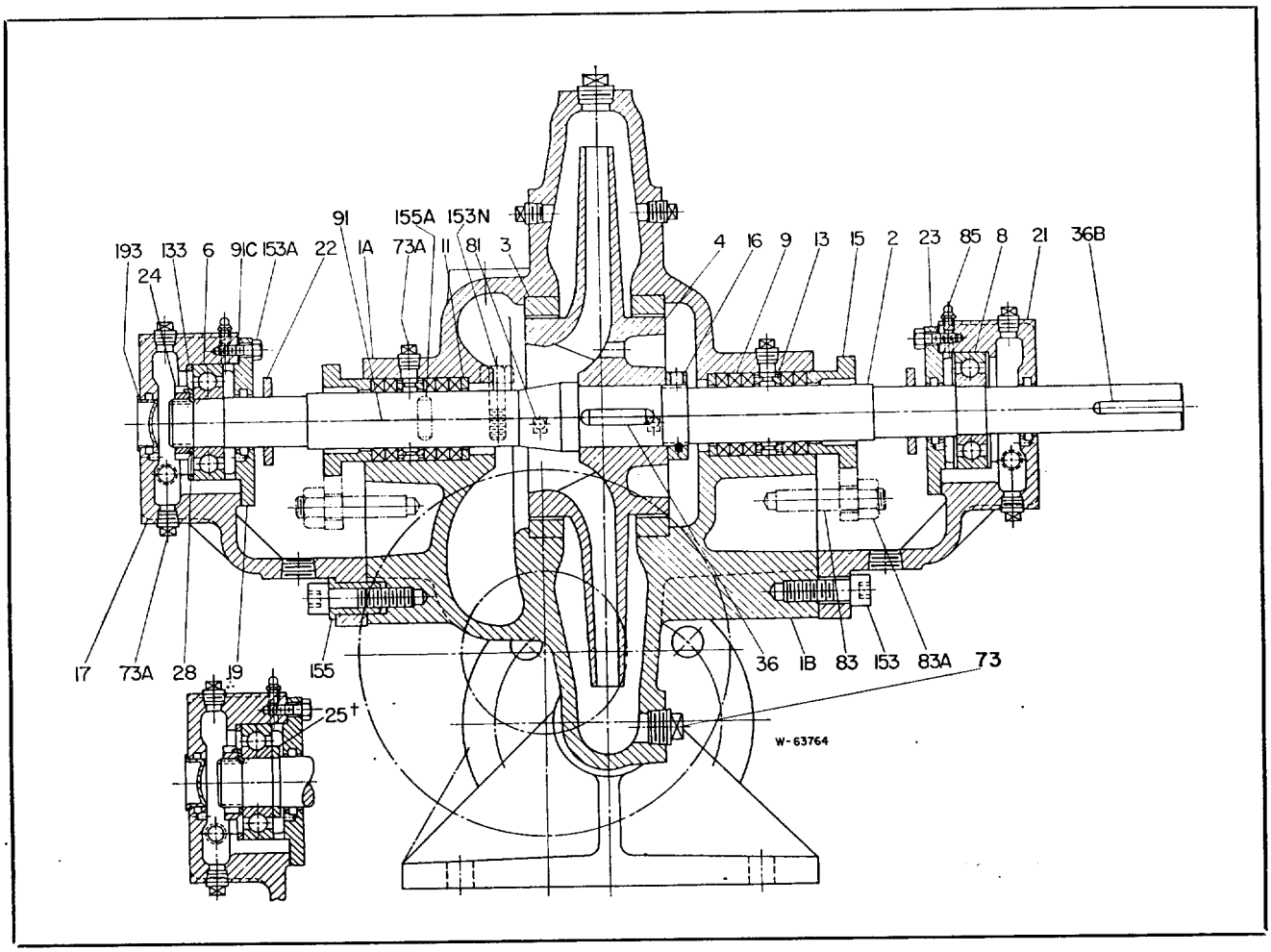
ITEM NO.	NAME OF PART
1A	CASING UPPER HALF
1B	CASING LOWER HALF
2	*SHAFT
3	*CASING RING
4	*IMPELLER (FIRST STAGE)
4A	*IMPELLER (SECOND STAGE)
6	*THRUST BEARING
7	*INTERSTAGE BUSHING
8	*LINE BEARING
9	PACKING
10	*SHAFT SLEEVE
11	*STUFFING BOX BUSHING
13	SEAL CAGE
14	*SHAFT NUT
15	GLAND
17	THRUST BEARING BRACKET
19	THRUST BEARING COVER
21	INBOARD BEARING BRACKET
22	*WATER SHIELD

ITEM NO.	NAME OF PART
23	LINE BEARING COVER
24	*BEARING LOCK NUT
28	*BEARING LOCK NUT WASHER
36	*IMPELLER KEY
36B	*COUPLING KEY
73	½ IN. PIPE PLUG
73A & C	¼ IN. PIPE PLUG
79	*"O" RING
81	*SET SCREW
83	GLAND STUD
83A	GLAND NUT
85	GREASE FITTING
91	*CASING GASKET
91A	*SLEEVE GASKET
91C	BEARING COVER GASKET
153	BEARING BRACKET SCREWS
153A	BEARING COVER CAP SCREWS
153N	CASING SPLIT CAP SCREWS
155	DOWEL BUSHINGS
155A	*ROLL PIN
193	DUST COVER
217	*SPACER SLEEVE

*Parts furnished with Rotating Assembly

TYPE LR CENTRIFUGAL PUMPS

PARTS LIST



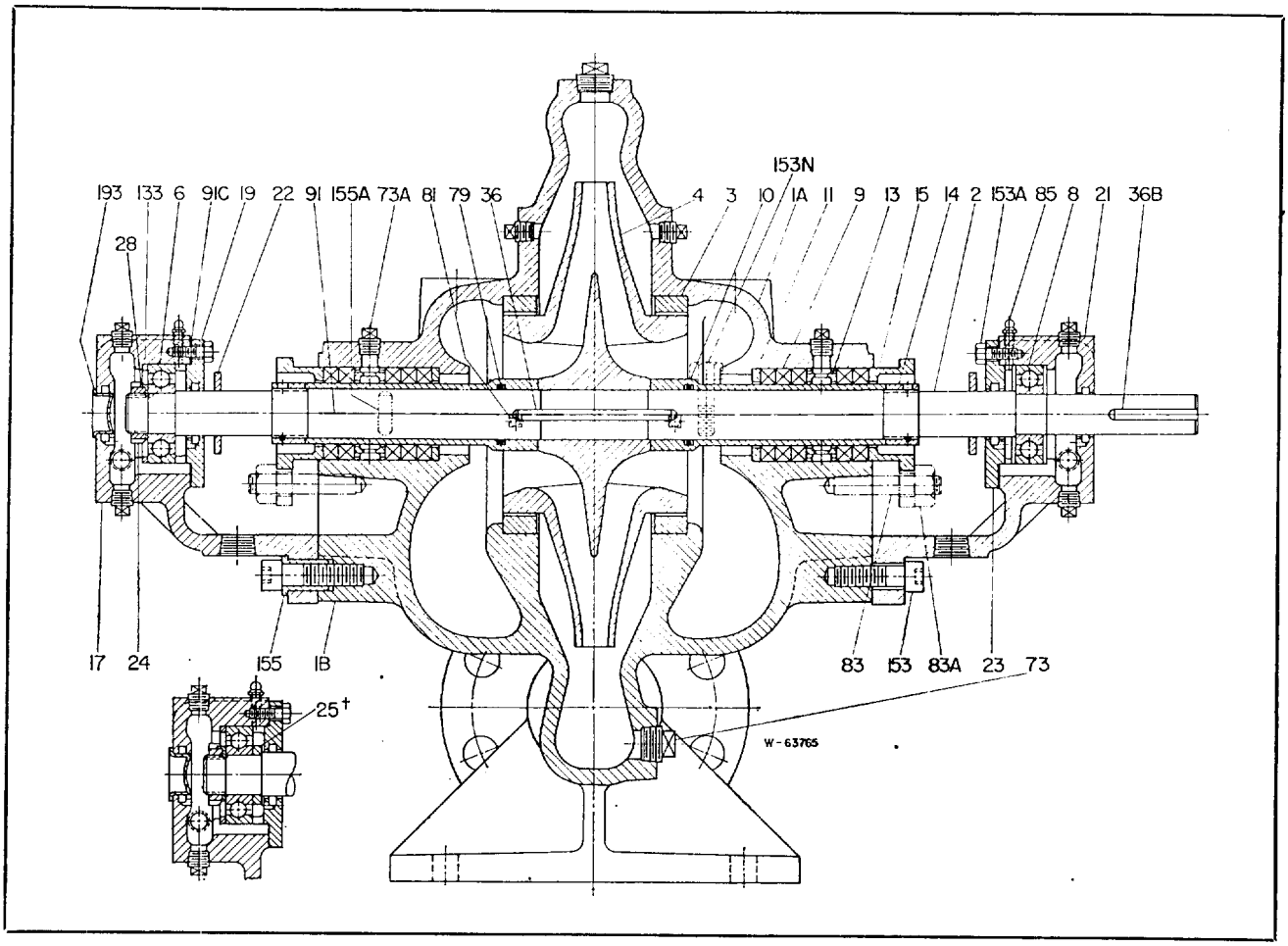
ITEM NO.	NAME OF PART
1A	CASING UPPER HALF
1B	CASING LOWER HALF
2	*SHAFT
3	*CASING RING
4	*IMPELLER
6	*THRUST BEARING
8	*LINE BEARING
9	PACKING
11	*STUFFING BOX BUSHING
13	SEAL CAGE
15	GLAND
16	*IMPELLER NUT
17	THRUST BEARING BRACKET
19	THRUST BEARING COVER
21	INBOARD BEARING BRACKET
22	*WATER SHIELD
23	LINE BEARING COVER
24	*BEARING LOCK NUT

ITEM NO.	NAME OF PART
25	BEARING SPACER
28	*BEARING LOCK NUT WASHER
36	*IMPELLER KEY
36B	*COUPLING KEY
73	½ IN. PIPE PLUG
73A	¼ IN. PIPE PLUG
81	*SET SCREW
83	GLAND STUD
83A	GLAND NUT
85	GREASE FITTING
91	*CASING GASKET
91C	BEARING COVER GASKET
133	SHIM
153	BEARING BRACKET SCREWS
153A	BEARING COVER CAP SCREWS
153N	CASING SPLIT CAP SCREWS
155	DOWEL BUSHING
155A	*ROLL PIN
193	DUST COVER

*Parts furnished with Rotating Assembly
†Furnished on 2½ LR-13 only

TYPE LR & LRG CENTRIFUGAL PUMPS

PARTS LIST



ITEM NO.	NAME OF PART
1A	CASING UPPER HALF
1B	CASING LOWER HALF
2	*SHAFT
3	*CASING RING
4	*IMPELLER
6	*THRUST BEARING
8	*LINE BEARING
9	PACKING
10	*SHAFT SLEEVE
11	*STUFFING BOX BUSHING
13	SEAL CAGE
14	*SHAFT NUT
15	GLAND
17	THRUST BEARING BRACKET
19	THRUST BEARING COVER
21	INBOARD BEARING BRACKET
22	*WATER SHIELD
23	LINE BEARING COVER

ITEM NO.	NAME OF PART
24	*BEARING LOCK NUT
25†	BEARING SPACER
28	*BEARING LOCK NUT WASHER
36	*IMPELLER KEY
36B	*COUPLING KEY
73	½ IN. PIPE PLUG
73A	¼ IN. PIPE PLUG
79	*"O" RING
81	*SET SCREW
83	GLAND STUD
83A	GLAND NUT
85	GREASE FITTING
91	*CASING GASKET
91C	BEARING COVER GASKET
133**	SHIM
153	BEARING BRACKET BOLT
153A	BEARING COVER BOLTS
153N	CASING SPLIT CAP SCREWS
155	DOWEL BUSHING
155A	*ROLL PIN
193	*** DUST COVER

*Parts furnished with Rotating Assembly
†Furnished on 4LR(G) - 11, 4LR - 14, 5LR(G) - 13.
**Not required for 10LR - 17, 10LR - 18, 12LR - 25, 16LR - 18, 16LR - 20
***Nameplate on 12LR - 17, 16LR - 18, 16LR - 20

TYPE LR-LLR CENTRIFUGAL PUMPS

RECOMMENDED SPARE PARTS—DOMESTIC

REF. NO.	NAME OF PART	QUANTITY
3	CASING RING W/SET SCREW NO. 81	2
6	THRUST BEARING	1
7	*INTERSTAGE BUSHING	1
8	LINE BEARING	1
9	STUFFING BOX PACKING	1 SET
10	†SHAFT SLEEVE W "O" RING NO. 79	2
11	STUFFING BOX BUSHING	2
22	WATER SHIELD	2
24	BEARING LOCK NUT	1
28	BEARING LOCK NUT WASHER	1
91	BEARING COVER GASKET	2
91C	CASING GASKET	1
193	DUST COVER	1
217	*SPACER SLEEVE W/GASKET NO. 91A	1

*Used on LLR Pumps only

†Used on all pumps except 2½ LR-10 and 2½ LR-13

EXPORT

(Recommended in Place of Above Parts)

—	ROTATING ASSEMBLY—COMPLETE	1
9	STUFFING BOX PACKING	2 SETS

NOTE: For pumps fitted with mechanical seals, substitute mechanical seals for packing in the above listed spares.

Worthington Division
McGraw-Edison Company
East Orange, New Jersey 07017

MEMBER

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